Public Report for Barrick Gold, ESA 075

Introduction:
The Pressure Oxidation plant (part of the Autoclave Facility) of the Goldstrike Mine, Barrick Gold of North America, Elko, NV was the focus of a 3-day steam system Energy Savings Assessment (ESA). The POX consists of the six autoclaves that process the slurry and the oxygen plant (operated by Air Liquide) that provides the oxygen for the autoclaves. All of the six autoclaves have five internal compartments with critical temperature control. The overall process is supplied with steam in the first two compartments and then the exothermic nature of the reaction due to the sulphides in the ore continues to maintain the heat in the subsequent compartments. Heat recovery from the slurry exiting the autoclaves is done using staged pressure flashing. This steam heats up the slurry that has yet to enter the autoclaves. The heat exchange is done in an extremely efficient counter-current, direct contact manner in splash towers. Downstream of the autoclaves, there is minimal steam demand and is beyond the scope of this ESA.

Objective of ESA:
The main objectives of the ESA were as follows:

- Identify steam system energy savings opportunities for the POX
- Use the DOE Steam tools such as the Steam System Scoping Tool (SSST), System Assessment Tool (SSAT) and the 3E Plus insulation software to model the steam system at the POX
- Assist POX personnel to gain familiarity and use all the above mentioned tools to identify energy efficiency improvement opportunities at the POX and quantify the energy savings associated with the steam system

Focus of Assessment: Steam Energy System

Approach for ESA:
An ESA plant team was first formed by the Plant Lead (Ron Valdez), which included personnel and leads from Operations, Maintenance and Process Control for the POX. From this plant team, a core ESA team was formed. The plant ESA core team included Steve Cashin, Wilson Tsu, Cameron Weins and Wayne Templeton. The plant core team first completed the Steam System Scoping Tool (SSST) on the POX steam system. This allowed the ESA expert to develop a thorough understanding of the plant's steam generation, distribution and end-use (autoclave heating) systems. It also helped to focus the core team's strategy for the Steam ESA. The core team applied the Steam System Assessment Tool (SSAT) and the 3EPlus to quantify potential steam system efficiency opportunities for propane and electrical energy savings. A 3-pressure header steam system in the SSAT was used to model the steam system at the POX. Detailed data collection from the PI data and historian system was done during the ESA by the core team by identifying data points that were critical and necessary to do the overall system analysis. The detailed quantified information and description for the potential improvement opportunities is provided in this report.

General Observations of Potential Opportunities:
There is a significant level (average plus) of industry steam bestpractices in place at the POX, which is also reflected in the score (76%) that the POX received on the SSST. Some of these bestpractices were mentioned in the table on Page 1. Additional potential energy savings and improvement opportunities were evaluated using the SSAT and the 3EPlus softwares.

The POX steam system has three propane-fired boilers - #2 and #3 each have a capacity of 100,000 lb/hr and #4 has a capacity of 200,000 lb/hr. Hence, the total system capacity is 400,000 lb/hr, but due to maintenance and other planned shutdowns, this capacity may not necessarily be available all the time. More importantly, plant demand has changed significantly over the years due to several process optimization strategies and the quality of the ore. Hence, overall steam (and propane) usage for the autoclaves has dropped by as much as 67% over the past couple of years. Based on discussions with Operations, there is a possibility that the steam demand at POX may increase again due to future processing of low suphide content ore.

In 2005, the average POX steam load was ~80,000 lb/hr at 560 psig (saturated steam). This resulted in total annual propane usage at the POX of ~3,700,000 gallons at an average propane cost of ~$1.1 per gallon (~$12/MMBtu). The autoclaves system of the POX also consumed ~40,000 MWh of electrical energy in 2005. The average cost of electricity at POX is $0.0966 per kWh.

Based on the Steam ESA on the POX steam system, most of the propane-fuel savings opportunities are identified in the steam generation area. Nevertheless some minimal opportunity does exist in the distribution area also. There are also electrical energy savings opportunities associated with the boilers and the steam system and hence, they were evaluated during this steam ESA. These energy savings opportunities are quantified in the table on Page 1 and are described briefly below and identified as Near, Medium and Long term (please refer to the definitions at the end of the report).

1. **Improve Boiler efficiency – Re-Calibrate flowmeters & improve control strategy (Near Term Opportunity)**
   All the boilers have sufficient instrumentation to calculate individual boiler efficiency. But based on the hourly average data collected for the year 2005, it was evident that flowmeters measuring the propane flow rate and/or steam flow rate on all the boilers needed calibration. Significant errors in the calculated efficiency values were observed. Once the instrumentation is re-calibrated, the efficiency calculated on these boilers can provide an excellent means to identify what boiler combination to operate for a given system steam load. Since, the boilers are not all of the same size this allows plant personnel to optimize the overall steam generation efficiency and ensure reliable operation. Secondly, this data can be trended and can be used as a means for identifying any maintenance issues that may be required on any boiler.

2. **Improve boiler efficiency – Install automatic oxygen trim controllers (Medium Term Opportunity)**
   This opportunity applies only to boilers #2 and #3. Currently, both these boilers have a positioning controller that is set once a year during the boiler inspection and burner tune up. Both these boilers can benefit with the use of an automatic oxygen trim controller similar to the one that operates on boiler #4. During the ESA, both these boilers were not operating and so actual stack temperatures and flue gas oxygen levels couldn’t be measured. Hence, a conservative estimate is made on the improvement of the operating efficiency based on a difference on the flue gas oxygen levels.

3. **Eliminate continuous boiler blowdown from sampling port (Near Term Opportunity)**
   To maintain proper boiler water chemistry and manage blowdown manually, plant personnel have installed sampling ports on the boiler blowdown. These sampling ports have been set by a manual valve to allow a continuous bleed of the blowdown all the time. When this blowdown flow was measured during the ESA using a bucket and stop-watch, it was found to be ~2 gpm (1000 lb/hr). This is a significant amount of lost energy that could be recovered in the flash tank or in the blowdown heat recovery exchanger that already exists in the system. This is also a safety hazard since it releases hot flashing water on the floor and can result in personnel injury. Alternatively, if a proper automatic blowdown controller is installed, then this problem can be eliminated completely and manual control of blowdown valve would not be needed.

4. **Add operation of back-pressure steam turbine – High pressure to low pressure (Medium Term Opportunity)**
   Steam is produced in the boilers at 560 psig and then reduced to 10 psig, using pressure reducing valves (PRV), for use in the deaerator. Since the steam system operates with 100% make-up, there is a significant amount of steam use by the deaerator and is directly proportional to the overall steam system demand. Instead of using a PRV, use of a back-pressure steam turbine that operates between the high pressure (560 psig) and low pressure (10 psig), would generate a significant amount of electricity. Alternatively, the steam turbine can be directly connected to a feedwater pump or any other current motor-driven equipment. This results in direct electrical energy savings at the expense of a slight increase in the fuel energy due to increased steam production. This opportunity was evaluated assuming an average steam flow rate of 80,000 lb/hr and using two turbines with ~40,000 lb/hr flow through each of them. This allows for 100% utilization of one turbine and ~75% utilization of the other turbine.

5. **Increase condensate recovery (Near Term Opportunity)**
   Currently, all the steam traps drain into the sump system. Plant personnel have done some basic analyses that have identified few traps that can be configured to return condensate back into the deaerator. This analysis identified ~1000 lb/hr of condensate could be recovered that is currently lost to the sumps.

6. **Improve steam insulation (Near Term Opportunity)**
   Certain flash vessels, steam distribution and other process equipment can benefit by improving the overall insulation. Some examples of these areas include: flanges and manway-covers on pressure

vessels, large valves, steam piping, etc. The 3EPlus program was used to estimate the energy loss per square foot and an estimate on the potential savings opportunity was provided.

7. **Deaerator energy saving opportunities (Near term Opportunity)**
   There were two energy saving opportunities that were observed on the deaerators. They are:
   - Eliminate steam venting to ambient on the hot standby boiler
     This mainly happens because the control valve that regulates steam flow from the high pressure (560 psig) header to the deaerator cannot seal tight and leaks steam. The valve is not designed to operate in this regime wherein a very small amount (<0.5%) of steam is required to keep the deaerator hot while the boiler is in hot standby.
   - Eliminate overflow of water from deaerator into the sump
     This seems to be a problem on boiler #4 and is probably the result of a faulty flow level transmitter or controller. Nevertheless, there is a continuous overflow of water from the deaerator through the float mechanism thereby resulting in a significant amount of energy and deionized water lost from the system.

8. **Use of variable frequency drive or a 2-speed drive on fan motors (Medium Term Opportunity)**
   Evaluation of individual boiler operation indicates that average operating loads for each of the boilers are at less than 50% capacity. Boiler #2 operates at an average of 39% of rated capacity, Boiler #3 operates at an average of 47% of rated capacity and Boiler #4 operates at an average of 36% of rated capacity. This is also due to the fact that the steam load from the autoclaves has significantly dropped. The forced draft fans are constant speed drives and the air flow is controlled by the discharge damper. Tremendous energy savings are possible by using a variable frequency drive on these forced draft centrifugal fans due to the cubic relationship between power and flow rate. Plant personnel have also reconfigured boiler #2 to be able to fire at real low levels and depending on an optimized strategy, that boiler could be configured to have a two-speed fan with operation of the boiler limited to low and high fire only.

It has to be noted that every mine has only a certain amount of "life" determined by the economic viability and purity level of the ore at any given point of time. The autoclaves operation in the POX is expected to last only another 2-5 years from the present. Hence, any time lost in implementation of these projects would make them all the more difficult to justify. Nevertheless, implementation of these energy saving opportunities will be determined by the plant team based on applicability, economic feasibility, risk assessment and operational complexity.

Management Support and Comments:
Management (both at corporate and local business plant level) has not set any energy reduction goals but plant personnel are actively pursuing energy saving opportunities that are economically viable. This is evident from the 67% reduction in propane fuel reduction that they have achieved over the past couple of years. The commitment from management was also evident from the fact that four plant personnel spent two and a half days working with the ESA Specialist during the Steam ESA. Even though the Steam ESA is complete, they will continue to work on monitoring critical data and implementing bestpractices and energy saving projects at the POX, thereby re-affirming their goals, strategy and vision for energy in their industry.

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Definitions
- Near term opportunities include actions that could be taken as improvements in operating practices, maintenance of equipment or relatively low cost actions or equipment purchases.
- Medium term opportunities require purchase of additional equipment and/or changes in the system such as addition of recuperative air preheaters and use of energy to substitute current practices of steam use etc. It would be necessary to carryout further engineering and return on investment analysis.
- Long term opportunities require testing of new technology and confirmation of performance of these technologies under the plant operating conditions with economic justification to meet the corporate investment criteria.